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ABSTRACT

The main proposal of this paper is to present research performed during a practical subject in the last year of the electrical engineer undergraduate course, emphasis in electrotechnics, at the Universidade Sao Judas Tadeu. Several activities are developed to provide the students variable and continued information about their performance in many important engineering skills, like leadership, vivacity, dynamism, reliability, speech, and synthesis capacity. Under the concept of feedback control systems, these techniques are made to reach the goal of meaningful engineering education. In this case, the system in point may be understood as "system learning" and has as a main action shield an informative and critical retroaction, not only at a technical level but also a competency one. The structure used is called canonical form of a feedback system. Under this structure, many of the system's aspects are shown, with parts being related, diagrammed, and discussed. In the end, some statistical results gathered between 1995-1997 will be shown, and a joint evaluation will be possible (Contains 16 references.) (YDS)

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# A DYNAMIC ACTION IN THE ENGINEERING TEACHING

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***Abstract***

*The main proposal of this working is to present an experience performed during a practical subject in the last year of the electrical engineer undergraduation course, emphasis in eletrotechnics, of the Universidade São Judas Tadeu.*

*Several activities are developed to provide the students variable and continued information about their performance in many important aspects which ought to be engineers knowledge nowadays, like leadership, vivacity, dynamism, reliability, speech, synthesis capacity, as well as others behaving and technical features.*

*Under the concept of feedback control systems, these techniques are made to reach goal. In this case, the system in point may be understood as a "system learning" and got as a main action shield an informative and critical retroaction, not only at a technical level, but also a behaving and continuously one.*

*The structure used is called canonical form of a feedback system. Under this structure, many of the system's aspects are shown, with parts being related, diagrammed and discussed.*

*In the end, some statistics results gathered between 1995-1997 will be shown, where become possible a joint evaluation, as previously proposed.*

## 1. Introduction

The quickness in which the modern word is growing is all related to the speed that information is transmitted.

Owing to this still increasing velocity, two items are becoming fundamental in the engineering formation: the knowledge of extra-areas and the joining of multidisciplinary teams [1].

Nowadays, it is extremely required for any engineer a general formation so as, in a short length of time, he would be able to solve any problem. A good formation for the future professional is effectively built through a basic, well-founded formation, bringing the engineer to a more general level than a particular one.

The actual tendency is the formation of multivalent professionals, who must have knowledge in many areas, getting away of the engineer universe, obliging them to participate in others areas, which ages ago, might not be their skills [2].

It is essential for the engineers nowadays the knowledge of foreign languages, economy, computers programs, business administration, sociology, so as many others areas, which are engineers' duties actually.

This forced a completely change in the engineers' profile in this last decade of the millennium, forcing the schools to reformulate their curriculum, with a view to adequate the engineers to the brand new tendencies of the career, just like the best universities in Europe, Japan, United States and Canada.

It all resulted in a turning in the engineering courses, so as to prepare the newly professionals with a wide view of engineering and a wide capacity to tackle the areas they will act.

These necessities are already found today, as it is seen the amount of engineering students and also engineers looking for others courses to "finally" complete their formation [3].

Many experiences supported in a wide range of theories have been presented with the same aim to improve and update the engineering teaching in Brazil, for instance, the methodology based in the "Control Theory" [4]. Others workings and experiments have been as well presented [5, 6].

The main proposal of this work is to present an experience, that has been accomplished since 1995, performed during a practical subject in the last year of the electrical engineer undergraduation course, emphasis in eletrotechnics, of the Universidade São Judas Tadeu (USJT), São Paulo, called "Laboratory IV" where several activities are developed along the year, in order to give students a different individual attention, and also in fixed and variant groups.

Under the concept of *feedback control systems*, these techniques are made to reach the differential formation of the engineer, preparing them to face the reality, today and in the future [7].

In this case, the system in point may be understood as a system learning and got as a main action shield an informative and critical retroaction, not only at a technical level, but also at behaving one,

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during the year in which the activities are developed; it is used a *canonical form of a feedback system*, where the exit of the system can be re-used, to increase its performance.

In the end, some statistics results will be shown, gathered during the presentation of the graduation works, which the Faculdade de Tecnologia e Ciências Exatas of the USJT gives plenty of attention and care.

## 2. Methodology

A system is the joining of components who act together to reach a certain goal and, under their concept, not only physical, but also abstracts and dynamics phenomenons (like biology, economics, business, etc) are analyzed and discussed.

It is natural when working with people, not only physicals phenomenons (pressure, temperature, etc.), but also a great number of others variables are considered due to the complexity of human being. However, in this work, it will be just used a single structure of a controlled feedback system.

The results were gathered during the presentation of the graduation works to the examining board, where, besides technical, all the behaving aspects were evaluated.

A block diagram representing this kind of system is known as *canonical form of a feedback system*, showed above:

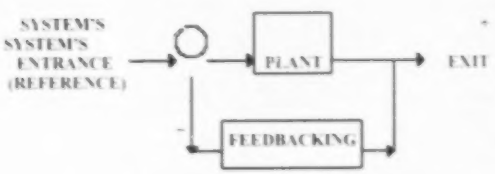


*Figure 1: Canonical Form of a Feedback System*

Control is the process of making a system variable adhere to a particular value, called the reference value. Two kinds of control were defined: *open-loop control* and *close-loop control*. In close-loop control the system uses *feedback*, which is the process of measuring a control variable and returning the output to influence the value of the variable [8].

At a system named *learning system*, the operator, and consequently the controller is the human being. He must always compare successively the reference and the exit, acting when necessary, making the corrections based in the differences or errors. Once the operator get used to the system, he could became a better controller, what should be taken into account in the system analysis [9].

According to figure 1, the following parameters are considered:

a) *System's Entrance (Reference)*: a graduation engineering student, able to start his engineering career at the development of functions, according to what is required nowadays;
b) *System's Exit*: student in the last year of the electrical engineer course at USJT, enrolled in the subject Laboratory IV;
c) *Plant (or process)*: all the activities developed in classroom and the work group;
d) *Feedbacking*: the wide range of analysis and comments about the acquired results in all activities available for the students;

The *Control Element* are the professors specialized in the techniques which try to bring students to the reference level.

Logically, all this parameters, mainly those related with the system's entrance (reference), are very discussible, which may vary according to many factors, for instance: interest region, school, profile of the engineer, etc.

The methodology is based in many activities along the last year of the course of electrical engineer of USJT, in the subject "Laboratory IV", what will be discussed next session. The works are developed not only individually, but also in fixed and variant groups.

As a result, it is expected a well performance of the students in the last year of their university's duties, technically, as well as behaving.

During all this process, it is fundamental the *feedbacking* along the year with the function to give all the students results and information of himself, of his working group, the others groups and the professors about the technical and behaving performance, either if he is in leadership position or not.

The function of the controller element is to administrate the working, criticism, self-criticism and results, disposing everything in order to get the best of each, at a professional and relaxing level. It is the controller responsibility to command the system, so as to be always conscious of the differences between the reference (system's entrance) and the final result (system's exit).

## 3. Activities Developed

During the last year of the course, a large number of activities are developed having in view to improve kidding, posture, speech, ability to control the time during a presentation, leadership, multidisciplinary study, synthesis and researching capability, development of proper materials for presentations, etc., with a view to reach the desired goals mentioned below [7, 9, 10].

Others common developed activities are followed described:

- *Self-presentation*: individual activity with a view to introduce each person to the professors and class colleagues, allowing a general knowledge of the

characteristics of the graduation student in terms of posture, kidding, speech and seriousness, showing which are the negatives and positives points of each student among these aspects [11];

- *Developing of an artefact*: activity in order to simulate labouring under pressure, where a determinate working must be finished in a fixed time, giving emphasis, in this process, on individually performance of each student as leadership, negotiation and giving spirit;
- *Environmental analysis and the construction of a technical commercial proposal*: activity which aims the necessity of arrangements, leadership spirit, environmental analysis, creativity and the construction of a technical / commercial proposal;
- *Subject discussion – A versus B and B versus A*: Group activity where negotiation skills, speech, group working, swapping of leaders and equip representation are evaluate;
- *Technical subject presentation*: another group activity, but individually evaluated. A technical subject is chosen and must be presented to the others classmates. Aim for a speech analysis, the ability to control time during presentation, the development of proper materials for presentation, criticism and self criticism under their positives and negatives aspects;
- *Engineer characteristics*: working which seeks to highlight the commons characteristics of the engineers: leadership, fast reasoning, autonomy, multidisciplinary knowledge, etc., are all detected in each person and discussed in a way to start a formation or improvement process of a professional and ethnical standard;
- *Presentation of correlate subjects*: the objective of this activity is to improve the supporting materials, the knowledge of correlate subjects of engineering, concepts of synthesis, speech, the ability to control time during presentation, criticism and self criticism under their positives and negatives aspects and discussion of the subject between the groups and the class as a role;
- *Discourse delivered by professionals*: not only does the activity rise the technical knowledge, but also let the graduation students to compare their own performances with a professional's one, with a view to establish a compare element of performances;
- *Report elaboration*: activity in order to improve the synthesis notions and the ability to write, obeying fixed aesthetics models [12, 13];
- *Product analysis*: it is a pleasant and interesting exercise where is analysed the *engineering* enclosed in an ordinary object, common in our everyday life.

It is important to note that the process is dynamic, and these activities may be added another, or rather suppressed, according with the class profile or the student particularly.

In the end of each activity, the results are discussed by the professors with the students, individually and in groups, allowing the students to have a feedback of them.

From this cyclical process each student get knowledge of his virtues and defects.

All this elements are observed and discussed (with a certain student or a group) under the professor's point of view, class colleagues, and also self-criticism. Therefore, each person may have himself analyzed by different point of views.

The developed activities are not steady, they may vary along the years, so as to make this process more dynamic, always updated, according to the profile of each group. To demonstrate, it is possible to mention the graduated group of 1995, where 75% of the students had a technical formation and were employed in projects or supporting areas. Nevertheless, the graduation group of 1997 had just 45% of the students with a technical formation, while the majority were acting in business administration areas.

Together with these activities, it is also developed an individually or group work, a multidisciplinary study in the engineer area, called "Graduation Work" (GW), which begins in the penultimate year of the course. The GW's emphasizes some aspects, like: researching, synthesis, technical report elaboration, activities development and monograph elaboration as well.

During the presentation of the GW's to the examining boards, all the process developed along the year is judged. Moreover, technical knowledge, monograph elaboration, speech, the ability to control the time, clarity, posture, etc are as well evaluated.

At USJT, in the Faculdade de Tecnologia e Ciências Exatas, the GW's are very complex and discussed, and their skills will be presented in another opportunity.

Following some results gathered during the presentation of the graduation works, between 1995-1997, are shown, when this working started to be done.

## 4. Conclusions

During the GW's presentation of the 1995-1997 groups, some data were gathered in a specific form, called *evaluation work*. From this data, an amazing increase in the topics mentioned in item three could be felt, in contrast with the students' performance before 1995.

It is important to mention the gradual improvement of each student too, accordingly the activities are gradually developed, and the effects of the feedbacking, criticism and information are absorbed and understood by them.

***The Increase In The Students' Individually***

| *Performance Between 1995-1997* | |
|---|---|
| **EVALUATED TOPIC** | **RISE (%)** |
| Kidding | 20 % |
| Posture | 85 % |
| Speech | 70 % |
| Time Control During Presentation | 95 % |
| Leadership | 65 % |
| Research | 70 % |
| Multidisciplinary Study | 95 % |
| Synthesis / Monograph | 55 % |
| Presentation | 85 % |
| ***Rise in the students' performance: 71.1%*** | |

*Figure 2: The Students Increasing Performance*

The table in figure 2, shows simply some of the main results and the items evaluated in this work, in comparison with the marks given to the graduation works before 1995, with the marks of it between 1995-1997.

Taking into account the natural aspects of each, hard to be improved (like the kidding for instance), and the non-natural aspects, easier to be modified (like the ability to control the time during the presentations), it was possible to estimate a 71.1% rise in the individually performance of each single student [15].

With the improvement of the applied activities, new and better ones, specialization and teaching of the professors and a better knowledge of the process, it is expected to increase this level even more, at a medium term, since this results and data may be gathered and studied once a year.

## 5. Future Workings Suggestions

This work may continue according to many others point of views. Among, it is possible to mention two of them, which at first sight, occur at a natural form: the fusion with others areas, for instance, the psychology, supporting and helping all the process; and the development of a scientific work at a mathematical level, which controls the feedback all as a group.

In the first suggestion, others professionals would certainly bring new ideas and methods, which would help in the process and in the probate of the results; in the second, a great step is finding a mathematical model which describes nearly the human being behavior in the particularly case, but the variables numbers may be huge, the adjust of them may be difficult, and the model may not be linear.

There are many parameters involved in every aspect of this Kind of system design. Many of them need to be determined accurately. However, in practical engineering, both the factors affecting them, and the design knowledge to determine them, may contain uncertainties, which results in fuzziness of the parameters and defects in the design quality [16].

Thus, a suggestion is a fuzzy decision-making method for an expert system to deal with the uncertainty of the parameters decision both in knowledge representation and in the inference model.

Besides these, another suggestion is to keep this work going along all the engineering course, what would give students the opportunity to have a better performance, even though it requires a great number of specialists professors in the conduction and evaluation of the developed activities.

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